REMARKS

The above-identified application was filed on the basis of an English language translation of an application originally filed in Germany and on which a claim for priority has been made. Applicant's attorney has now reviewed and edited the specification of the aforesaid English language translation and has made editorial, syntactic and grammatical corrections. The attached substitute specification reflects all of the aforesaid corrections and none introduce any new matter to the originally filed specification. A "Version With Markings to Show Changes Made" is attached hereto.

Further, Claims 1-11 have now been amended to comply with United States claim format. A "Version With Markings to Show Changes Made" is attached hereto.

By this amendment, applicant believes the specification and claims are in better form for examination, and an action on the merits is awaited.

Respectfully submitted,

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Version With Markings to Show Changes Made

SPECIFICATION

~~FIELD~~BACKGROUND OF THE INVENTION

[0001] The **present** invention relates to an apparatus for generating surface pressure, in particular in an injection molding machine, having a stationary carrier platen and a clamping platen which can be moved in relation to said carrier platen and locked in a working position and which, on its side facing the carrier platen, has a closing platen that can be moved ~~out~~ electromechanically~~;~~. **The** material to be pressed or tools to be clamped ~~being~~**are** disposed between said closure platen and the carrier platen.

[0002] Generating a surface pressure ~~in this way~~**as described above** is **generally** known ~~in principle~~ from **the reference** DE 43 36 572 ~~C1. In~~ **C1. As disclosed in** this ~~case~~**reference**, the clamping platen and closing platen of an injection molding machine are moved relatively quickly by a first moving mechanism, and then the clamping platen is locked in the working position. The injection molding operation is started and, in order to cushion the forces originating from the plastics flow front, the closing platen is moved out by an alternating magnetic field being applied to a positively magnetostrictive material.

[0003] However, an electromechanical movement acting on this principle has the disadvantage that relatively high current intensities are needed. In addition, a permanent current has to be maintained, even in the stationary state.

[0004] It is an object of the invention to construct an apparatus for generating surface pressure of the type mentioned ~~at the beginning~~**above** in such a way that a rapid and powerful electromechanical movement is achieved in the technically simplest possible way.

SUMMARY OF THE INVENTION

[0005] According to the **present** invention, ~~this~~**the above-stated** object is achieved by the compressive force of the closing platen, ~~and~~**with** the action of moving ~~it~~**the closing platen** at the working point being implemented by piezoelectric actuators. **While these components have been used for a long time for various tasks in engineering, neither have been proposed nor used for moving closing platens in apparatus for generating surface pressure.**

~~[0006] These components have been tried and tested for a long time for various tasks in engineering, but have neither been proposed nor used for moving closing platens in apparatus for generating surface pressure.~~

~~[0006] [0007] A first advantageous~~**One** embodiment of the invention is characterized by the fact that the piezoelectric actuators are distributed ~~as desired~~, preferably in matrix fashion, over the area between clamping platen and closing platen. This results in an arrangement of the actuators which can be implemented simply in ~~technical terms and is~~**technically** comprehensible **terms**. However, it is also possible for the piezoelectric actuators to be distributed over the area between clamping platen and closing platen in accordance with the desired force distribution (**i.e.,** hardware implementation of the force distribution). The manner in which such an arrangement is to be made can be determined analytically or by means of trials. A second possibility ~~of~~, corresponding with a force distribution, consists in actuating the piezoelectric actuators differently (**i.e.,** software implementation of the force distribution).

~~[0007] [0008] The fact that, in~~**In** the event ~~of~~**that** ~~dynamic~~**the** behavior of the material to be pressed or the tools to be clamped **exhibits a dynamic behavior**, the piezoelectric actuators can ~~likewise~~ be triggered dynamically, ~~matched~~ to **match** said behavior, ~~means~~**such** that the ~~response~~**responsive** behavior can be configured so as not to damage the machine.

~~[0008] [0009]~~ For the case in which relatively long distances have to be bridged with the aid of the piezoelectric actuators, it proves to be advantageous if the closing platen can also be locked in at least one intermediate position which makes up a piezoelectric stroke and from which the clamping platen can subsequently be guided, the latter then being locked and the closing platen being moved out by a further piezoelectric stroke.

~~[0009] [0010]~~ The piezoelectric actuators can be produced with any desired geometry~~, preferably cube-like,~~ in accordance with ~~the~~ production possibilities, and can therefore be matched relatively easily to all machine requirements. **A cube-like geometry is preferred.**

~~[0010] [0011] It is certainly possible for additional~~**Additional** piezoelectric sensors ~~to~~**may** be provided between closing platen ~~and~~ clamping platen, ~~in order~~**so** that pressure measurements can be performed completely independently of the piezoelectric actuators. However, it is also possible that, during operation, a subset of the piezoelectric actuators can be used as piezoelectric sensors and, likewise, it is also possible that, during operation, piezoelectric actuators can be used briefly as piezoelectric sensors. The ~~two last-named~~**foregoing** alternatives have the advantage that double use of the piezoelectric actuators is made, ~~by~~**with** the latter being used as piezoelectric sensors.

DRAWINGS

~~[0011] [0012]~~ An exemplary embodiment of the invention is illustrated in the ~~drawing~~**drawings** and ~~will be~~**is** explained in more detail below. In the drawing:

~~FIG. 1~~ **FIGURE 1** shows elements of a plastic injection molding machine~~;~~; and

~~FIG. 2~~ **FIGURE 2** shows ~~a possible~~**an** arrangement of piezoelectric actuators.

DETAILED DESCRIPTION OF THE INVENTION

~~[0012] [0013]~~ In ~~the illustration of FIG. 1, elements~~**FIGURE 1, the components** of a plastic injection molding machine which are essential to the present invention are shown. ~~This~~ **The** machine is shown in the extended state, in which two half molds FH1 and FH2 are spaced apart from each other, so that a finished molding~~,~~ (not shown for reasons of clarity~~,~~) can be removed from the machine. The half mold FH1, ~~whose~~**has an** internal contour **which** is indicated by a dashed line~~,~~ **and which** is fixed to a stationary carrier platen TP. From the latter, spars extend from each ~~comer~~**corner**, of which only the spars H1 and H2 can be seen in the illustration. On these spars, for example the spars H1 and H2, a clamping platen AP can be moved bidirectionally and relatively quickly by a drive, which is not shown for reasons of clarity~~, this~~. **This** movement ~~being~~**is** indicated by a double arrow. A closing platen SP is also arranged, together with the clamping platen AP, in a sliding manner on the spars, for example the spars ~~HH~~**H1** and ~~H2, piezoelectric~~**2. Piezoelectric** actuators ~~being~~**are** disposed between the clamping platen AP and the closing platen SP, of which only the piezoelectric actuators ~~P1~~**P1** to P7 can be seen in the illustration according to ~~FIG.~~ **FIGURE** 1. In order to protect the piezoelectric actuators against inadmissible tensile stresses, they are mounted between the closing platen SP and the clamping platen AP so as to be prestressed mechanically.

~~[0013] [0014]~~ When a workpiece is to be created, the clamping platen AP and closing platen SP are moved in such a way that the half molds ~~FHH~~**FH1** and FH2 butt against each other. The clamping platen AP is then locked in its position in a force-fitting and/or form-fitting manner with respect to the spars, for example the spars H 1 and H2, by aids which are likewise not illustrated for reasons of clarity, and the thermoplastic material can be injected into the space between the half molds ~~FHH~~**FH1** and FH2. However, in order to compensate for mechanical deformations in the overall system, the flow pressure of the injected material must be opposed by the half mold FH2 with a deflection defined by the mechanics of the machine, which is carried out with the aid of the piezoelectric actuators, which are actuated electrically for this purpose. This activation can in this case be carried out simultaneously for all the actuators or else by means of an adapted, chronologically staggered reaction of the piezoelectric actuators in accordance with the propagation properties of the plastic between the half molds FH 1 and FH2.

~~[0014] [0015]~~ The fact that the piezoelectric actuators are ~~disposed~~ distributed over the area of the closing platen SP can be taken from the illustration of ~~FIG.~~ **FIGURE** 2, which shows that, in addition to one row of piezoelectric actuators, still further rows of piezoelectric actuators can be provided. The number and the geometry of the piezoelectric actuators depends on the required closing force and the ~~expansions~~**expansion** of the apparatus for generating surface pressure which have to be compensated for. The strictly matrix-like arrangement, preferably shown here**, however** can certainly be varied~~, however,~~ in accordance with the machine requirements, and can be selected ~~in~~ as desired. To this end, the mechanical behavior of the system has to be determined for the tools and machines used.

~~[0015] [0016] It is essential to~~**In** the present invention ~~that such~~ a determination of the mechanical relationships can be carried out, during operation, by ~~in each case~~ a subset of the piezoelectric actuators ~~being~~**while** used as piezoelectric sensors. These actuators do not then have a control voltage applied to them which triggers a piezoelectric stroke. **Instead**, ~~instead~~ the generator behavior of the actuators is used, specifically that under the influence of a force, a voltage can be tapped off across the actuators. In principle, it is also ~~conceivable~~**possible** for **some or** all the actuators ~~in each case~~ to be used briefly as sensors**. In this case**, it ~~then~~**will** ~~being~~**be** necessary, of course, to take into consideration the tolerable movements of the available masses ~~for this purpose~~. As an alternative, or as an addition ~~to this~~, however, it would certainly be possible for further piezoceramics, used only as sensors, to be disposed between the piezoelectric actuators and, on account of their smaller dimensions, still ~~to~~ find space ~~there~~**therefor**.

~~[0016] [0017] For~~**In** the case in which the distances which can be triggered by the piezoelectric actuators are too small for the machine behavior, the closing platen SP can be fixed in

a force-fitting and/or form-fitting manner, just like the clamping platen AP, by means of a mechanism, likewise not shown for reasons of clarity. Initially, the closure platen SP will not be locked and, starting from a locked clamping platen AP, a piezoelectric stroke will be carried out. The closing platen SP will then be locked and then the unlocked clamping platen AP will subsequently be guided and locked, and then the closure platen SP will be released and a further piezoelectric stroke brought about.

~~[0018]~~ Apparatus for generating surface pressure are understood to mean not only injection molding machines but, for example, also other pressing and compressing machines in production engineering.

~~FIELD~~BACKGROUND OF THE INVENTION

[0001] The **present** invention relates to an apparatus for generating surface pressure, in particular in an injection molding machine, having a stationary carrier platen and a clamping platen which can be moved in relation to said carrier platen and locked in a working position and which, on its side facing the carrier platen, has a closing platen that can be moved ~~out~~ electromechanically~~,~~. **The** material to be pressed or tools to be clamped ~~being~~**are** disposed between said closure platen and the carrier platen.

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[0003] However, an electromechanical movement acting on this principle has the disadvantage that relatively high current intensities are needed. In addition, a permanent current has to be maintained, even in the stationary state.

[0004] It is an object of the invention to construct an apparatus for generating surface pressure of the type mentioned ~~at the beginning~~**above** in such a way that a rapid and powerful electromechanical movement is achieved in the technically simplest possible way.

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[0005] According to the **present** invention, ~~this~~**the above-stated** object is achieved by the compressive force of the closing platen, ~~and~~**with** the action of moving ~~it~~**the closing platen** at the working point being implemented by piezoelectric actuators. **While these components have been used for a long time for various tasks in engineering, neither have been proposed nor used for moving closing platens in apparatus for generating surface pressure.**

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~~[0007]~~ ~~[0008]~~ ~~The fact that, in~~**In** the event ~~of~~**that** ~~dynamic~~**the** behavior of the material to be pressed or the tools to be clamped **exhibits a dynamic behavior**, the piezoelectric actuators can ~~likewise~~ be triggered dynamically, ~~matched~~ to **match** said behavior, ~~means~~**such** that the ~~response~~**responsive** behavior can be configured so as not to damage the machine.

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~~[0009]~~ ~~[0010]~~ The piezoelectric actuators can be produced with any desired geometry~~, preferably cube-like,~~ in accordance with ~~the~~ production possibilities, and can therefore be matched relatively easily to all machine requirements. **A cube-like geometry is preferred.**

~~[0010]~~ ~~[0011]~~ ~~It is certainly possible for additional~~**Additional** piezoelectric sensors ~~to~~**may** be provided between closing platen ~~and~~ clamping platen, ~~in order~~**so** that pressure measurements can be

performed completely independently of the piezoelectric actuators. However, it is also possible that, during operation, a subset of the piezoelectric actuators can be used as piezoelectric sensors and, likewise, it is also possible that, during operation, piezoelectric actuators can be used briefly as piezoelectric sensors. The ~~two last-named~~**foregoing** alternatives have the advantage that double use of the piezoelectric actuators is made, ~~by~~**with** the latter being used as piezoelectric sensors.

DRAWINGS

~~[0011] [0012]~~ An exemplary embodiment of the invention is illustrated in the ~~drawing~~**drawings** and ~~will be~~**is** explained in more detail below. In the drawing:

~~FIG. 1~~ **FIGURE 1** shows elements of a plastic injection molding machine~~;~~**;** and

~~FIG. 2~~ **FIGURE 2** shows ~~a possible~~**an** arrangement of piezoelectric actuators.

DETAILED DESCRIPTION OF THE INVENTION

~~[0012] [0013]~~ In ~~the illustration of FIG. 1, elements~~**FIGURE 1, the components** of a plastic injection molding machine which are essential to the present invention are shown. ~~This~~ **The** machine is shown in the extended state, in which two half molds FH1 and FH2 are spaced apart from each other, so that a finished molding~~,~~ (not shown for reasons of clarity~~;~~) can be removed from the machine. The half mold FH1, ~~whose~~**has an** internal contour **which** is indicated by a dashed line~~,~~ **and which** is fixed to a stationary carrier platen TP. From the latter, spars extend from each ~~comer~~**corner**, of which only the spars H1 and H2 can be seen in the illustration. On these spars, for example the spars H1 and H2, a clamping platen AP can be moved bidirectionally and relatively quickly by a drive, which is not shown for reasons of clarity~~, this~~**. This** movement ~~being~~**is** indicated by a double arrow. A closing platen SP is also arranged, together with the clamping platen AP, in a sliding manner on the spars, for example the spars ~~HH~~**H1** and H~~2, piezoelectric~~**2. Piezoelectric** actuators ~~being~~**are** disposed between the clamping platen AP and the closing platen SP, of which only the piezoelectric actuators ~~P1~~**P1** to P7 can be seen in the illustration according to ~~FIG.~~ **FIGURE** 1. In order to protect the piezoelectric actuators against inadmissible tensile stresses, they are mounted between the closing platen SP and the clamping platen AP so as to be prestressed mechanically.

~~[0013] [0014]~~ When a workpiece is to be created, the clamping platen AP and closing platen SP are moved in such a way that the half molds ~~FHH~~**FH1** and FH2 butt against each other. The clamping platen AP is then locked in its position in a force-fitting and/or form-fitting

manner with respect to the spars, for example the spars H 1 and H2, by aids which are likewise not illustrated for reasons of clarity, and the thermoplastic material can be injected into the space between the half molds ~~FH1~~**FH1** and FH2. However, in order to compensate for mechanical deformations in the overall system, the flow pressure of the injected material must be opposed by the half mold FH2 with a deflection defined by the mechanics of the machine, which is carried out with the aid of the piezoelectric actuators, which are actuated electrically for this purpose. This activation can in this case be carried out simultaneously for all the actuators or else by means of an adapted, chronologically staggered reaction of the piezoelectric actuators in accordance with the propagation properties of the plastic between the half molds FH 1 and FH2.

~~[0014] [0015]~~ The fact that the piezoelectric actuators are ~~disposed~~ distributed over the area of the closing platen SP can be taken from the illustration of ~~FIG.~~ **FIGURE** 2, which shows that, in addition to one row of piezoelectric actuators, still further rows of piezoelectric actuators can be provided. The number and the geometry of the piezoelectric actuators depends on the required closing force and the ~~expansions~~**expansion** of the apparatus for generating surface pressure which have to be compensated for. The strictly matrix-like arrangement, preferably shown here**, however** can certainly be varied~~, however,~~ in accordance with the machine requirements, and can be selected ~~in~~ as desired. To this end, the mechanical behavior of the system has to be determined for the tools and machines used.

~~[0015] [0016] It is essential to~~**In** the present invention ~~that such~~ a determination of the mechanical relationships can be carried out, during operation, by ~~in each case~~ a subset of the piezoelectric actuators ~~being~~**while** used as piezoelectric sensors. These actuators do not then have a control voltage applied to them which triggers a piezoelectric stroke**. Instead**, ~~instead~~ the generator behavior of the actuators is used, specifically that under the influence of a force, a voltage can be tapped off across the actuators. In principle, it is also ~~conceivable~~**possible** for **some or** all the actuators ~~in each case~~ to be used briefly as sensors**. In this case**, it ~~then~~**will** ~~being~~**be** necessary, of course, to take into consideration the tolerable movements of the available masses ~~for this purpose~~. As an alternative, or as an addition ~~to this~~, however, it would certainly be possible for further piezoceramics, used only as sensors, to be disposed between the piezoelectric actuators and, on account of their smaller dimensions, still ~~to~~ find space ~~there~~**therefor**.

~~[0016] [0017] For~~**In** the case in which the distances which can be triggered by the piezoelectric actuators are too small for the machine behavior, the closing platen SP can be fixed in a force-fitting and/or form-fitting manner, just like the clamping platen AP, by means of a mechanism, likewise not shown for reasons of clarity. Initially, the closure platen SP will not be locked and, starting from a locked clamping platen AP, a piezoelectric

stroke will be carried out. The closing platen SP will then be locked and then the unlocked clamping platen AP will subsequently be guided and locked, and then the closure platen SP will be released and a further piezoelectric stroke brought about.

~~[0018]~~—Apparatus for generating surface pressure are understood to mean not only injection molding machines but, for example, also other pressing and compressing machines in production engineering.

~~Patent Claims~~

Patent Claims

1. An apparatus for generating surface pressure~~,~~ in ~~particular in an injection molding~~a machine~~, having~~ **which exerts a compressive force on a material during operation of the machine comprising** a stationary carrier platen ~~and~~, a clamping platen which can be moved in relation to said carrier platen and locked in a working position, and ~~which, on its side facing the carrier platen, has~~ a closing platen that can be moved electromechanically, **wherein the** material ~~to be pressed or tools to be clamped being~~**is** disposed between said ~~closure~~**closing** platen and the carrier platen, ~~characterized in that~~**and further wherein** the compressive force of the closing platen ~~and the action of moving it at the working point are implemented with~~**is actuated by** piezoelectric actuators.

2. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that~~**wherein** the piezoelectric actuators are distributed ~~as desired, preferably~~ in **a** matrix fashion; over the area between clamping platen ~~(AP)~~ and closing platen ~~(SP)~~.

3. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that~~**wherein** the piezoelectric actuators ~~(P1 1-Pnn)~~ are distributed over the area between clamping platen (AP) and closing platen (SP) in accordance with a desired force distribution.

4. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that~~**wherein** the piezoelectric actuators ~~(P11-Pnn)~~ are actuated differently over the

area between clamping platen ~~(AP)~~ and closing platen ~~(SP)~~ in accordance with a desired force distribution.

5. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that in~~**wherein** the ~~event of~~**material subjected to the compressive force has a** dynamic behavior ~~of the material to be pressed or the tools to be clamped (FH1, FH2),~~**and** the piezoelectric actuators ~~can likewise be~~**exhibit a matching behavior when** triggered ~~dynamically, matched to said behavior~~.

6. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that a specific~~**wherein the** number of piezoelectric actuators ~~is needed, which~~**utilized** is derived from the ~~necessary forces and expansions~~**closing force of the platen**.

7. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that~~**wherein** the closing platen ~~(SP)~~ can ~~also~~ be locked in at least one intermediate position which ~~makes up~~**constitutes** a piezoelectric stroke and from which the clamping platen ~~(AP)~~ can subsequently be guided, the latter then being locked and the closing platen ~~(SP)~~ being moved out by a further piezoelectric stroke.

8. The apparatus ~~for generating surface pressure as claimed in~~**according to** claim 1, ~~characterized in that~~**wherein** the piezoelectric actuators ~~(P11-Pnn) are produced with any desired geometry, preferably~~**have a** cube-~~-~~like~~, in accordance with the production possibilities~~ **geometry**.

9. The apparatus ~~for generating surface pressure, characterized in that additional~~**according to claim 1, wherein** piezoelectric sensors are provided between closing platen ~~(SP)~~ and clamping platen ~~(AP)~~.

10. The apparatus ~~for generating surface pressure as claimed in claims 1 and 2, characterized in that during operation,~~**according to claim 1, wherein** a subset of the piezoelectric actuators ~~(P11-Pnn)~~ can be used as piezoelectric sensors.

11. The apparatus ~~for generating surface pressure as claimed in claims 1 and 2, characterized in that during operation,~~**according to claim 1, wherein at least one** piezoelectric ~~actuators (P1 1-Pnn)~~**actuator** can be used ~~briefly~~ as piezoelectric ~~sensors~~**sensor**.

Abstract

Apparatus for generating surface pressure in **for example** an injection molding machine~~.~~ **wherein the machine has a stationary carrier platen, a clamping platen and a closing platen that can be moved electromechanically, and wherein the material to be molded is disposed between the closing and carrier platen. The compressive force of the closing platen is actuated by piezoelectric actuators.**

~~In an injection molding machine, rapid movement over long distances is carried out with the aid of conventional means, as is the action of locking in the working position. The novel feature is, then, that in order to hold counter to the flow front of the injected material, piezoelectric actuators (P11 to Pnn) are used.~~